UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DEC 2 2 2015

ASSISTANT ADMINISTRATOR
FOR ENFORCEMENT AND
COMPLIANCE ASSURANCE

Tony Skatell
eCycling International, LLC
538 Multitex Street
Ulmer, SC 29849

Dear Mr. Skatell

This is in response to your email of July 31, 2015, to Marcia Mia of my staff, requesting a determination of applicability for a planned project by eCycling International LLC (eCycling) under 40 CFR part 60 subpart Ec – Standards of Performance for New Stationary Source: Hospital/Medical/Infectious Waste Incinerators (HMIWI). eCycling is proposing to install a Plasma Assisted Pyrolytic System (PAPS), developed by Paragon Waste Solutions, LLC, in Ulmer, SC. You had previously submitted a permit application and supporting information to the South Carolina Department of Health and Environmental Control (DHEC), and which they provided to us under separate cover. In addition to these materials, staff from the Office of Air Quality Planning and Standards (OAQPS), Office of Compliance (OC), Office of General Counsel (OGC), EPA Region IV, SC DHEC, and Paragon Waste Solutions, LLC, have had several phone calls and email exchanges with you to discuss additional details. According to the information you provided to us, we developed the following summary which we will use to make our determination. We shared this summary with you, prior to making this determination, to ensure that we were in agreement on the details that you provided. In addition to the details provided, there was discussion as to whether the exemption at §60.50c(f) for "any pyrolysis unit" might apply to the PAPS. On the basis of the details you provided, EPA has determined that the exemption for "any pyrolysis unit" does not apply. Furthermore, if constructed and operated as described, the PAPS will be subject to 40 CFR part 60 subpart Ec (HMIWI standards).

Background

1. The system is described technically as a "plasma assisted pyrolytic system" (PAPS) with a trademark name "CoronaLux".
2. The system will be installed by eCycling in Ulmer SC.
3. The system will be used to destroy hospital, medical and infectious waste with no energy recovery or subsequent use of the gaseous emissions stream.

4. Based on the construction date, if subject to HMIWI standards, the unit would be a new source.

CoronaLux system

1. The CoronaLux system consists of three chambers:
    a. Primary Chamber
    b. Low energy plasma chamber
    c. Residence chamber
2. The system can process approximately 2000 pounds of waste per batch and each batch takes approximately four to six hours to complete depending on the nature, density and composition of the waste.
3. The system is integrated such that streams generated from the primary chamber flow directly to the low energy plasma chamber to the residence chamber. This flow occurs continuously within the batch.
4. After the low energy plasma chamber, the stream is routed to the residence chamber. In the event the waste would contain precursors for the formation of acidic gasses, an insert containing a caustic scrubber would be introduced within the residence chamber and the gas routed through the insert in the residence chamber.[1]

Primary Chamber

1. The primary chamber has two natural gas burners. The flame from the natural gas burner is directed into the primary chamber. In order to insure that the flame does not come in direct contact with the waste, eCycling will install a metal shield to completely cover the flame.
2. The natural gas burner is operated "rich" to limit excess air introduced into the primary chamber.
3. The burners heat the primary chamber and initiate the process by reaching ignition temperature of the waste, but the burner flame does not directly contact the waste for such ignition.
4. The natural gas burners will turn off once the desired temperature is reached, but will then modulate on and off throughout the process to maintain the temperature in the primary chamber when waste flow is inconsistent (eCycling states that this is often the case). When the burners are "on" the burner flame(s) will not come in direct contact with the waste.
5. Operating temperature is 600-900F, but can reach as high as 1500F, depending on the nature of the waste. Specifically, towards the end of the cycle the temperature will be increased to maximize the removal of carbon from the ash.

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[1] This determination is not predicated on whether a caustic scrubber is installed. eCycling should work with their delegated authority to determine whether a caustic scrubber will be needed.

6. The chamber is endothermic[2] as demonstrated by the heat load provided by the burners. The burners inject as many as 6 million BTU per hour. The added heat is needed when the "gases" coming off the waste are inconsistent. The gases coming out of the first chamber are hot in order to maintain temperature in the rest of the system. The initial phases are where most of the H_2O is formed, and the cooling effect of the water due to its high specific heat works to keep temperatures low. The large volume of gases during the initial stages also maintains a constant flow, carrying heat away. As the reaction proceeds to its end, the water is entirely depleted and does not provide any cooling. The flow out of the chamber drops significantly, so the system tends to sit as a hot box due to the extensive insulation. At the end of the batch there also tends to form more short chain hydrocarbons than long chain hydrocarbons, and the short chains tend to have a higher calorific value when they decompose, which pushes the temperature up.
7. The typical operating conditions for the primary chamber include an initial purge cycle prior to ignition of the burners. This is a safety feature to ensure there are no combustible components in the atmosphere surrounding the waste.[3] The purge cycle is preset and runs for two minutes. Following the purge the air inlet valves automatically close, and the burner ignition sequence begins. The suction fan acting on the chamber runs continually during the cycle, with the chamber under a vacuum of approximately 8-10 inches of water column (approximately 1/3 psi). Most of the air is evacuated following the closure of the valves, and the small amount of remaining air is immediately consumed when the burners turn on. No oxygen is added and the burner runs fuel rich to avoid excess air being introduced. Once the burners turn on, the chamber fills with burner combustion gases and the fan runs continuously to evacuate the chamber and keep it under vacuum. Once the waste begins to break down, the gases coming from the waste also fill the chamber. The primary chamber volatilizes any intermediate char, oils, or related products to produce a gas such that the composition of the chamber will consist of hydrocarbons, CO_2, H_2O, CO, Oil droplets, soot, tar, and associated compounds.

Low Energy Plasma Chamber

1. Resultant gas from Step "7" above enters the low energy plasma chamber. eCycling refers to this gas as "smoke."
2. There is one natural gas burner located in the plasma chamber.
3. The chamber operates at approximately 1200F to 1500 F depending on the BTU value of the "smoke" generated.
4. The process is a free radical accelerated oxidation process.

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[2] Based on the temperature profiles that you provided for the primary chamber, EPA is not convinced that the entire process within the primary chamber is endothermic. However, for the reasons discussed in the body of our response, we are not basing our determination on whether the chamber is a pyrolysis unit; ergo, whether the process in the primary chamber is endothermic does not have bearing.

[3] Based on the temperature profiles that you provided for the primary chamber, EPA is not convinced that the chamber is evacuated. See discussion in the body of the letter.

5. The low energy plasma system[4] is best described as an electron gun where the gun creates an electron cascade at the end of the tube and releases these electrons into the chamber.
6. The electron gun is not a high temperature source. The electrons have a low thermal load, but very high kinetic energy.
7. The electrons generated in this way collide with molecules in the chamber, and in turn ionize those molecules. The ionized molecules of free radicals formed in turn react with the hydrocarbon stream to accelerate the free radical oxidation process that naturally takes place with hydrocarbons.
8. The process is exothermic.
9. The only "conventional combustion" in the plasma chamber is from the burner used to maintain the temperature constantly and at the set point.

Residence Chamber

1. The purpose of the chamber is to complete the oxidation process of the remaining carbon based particulates. The particles are in the ppm range, making it impossible to create a conventional "flame" or "combustion."
2. There is one natural gas burner in the residence chamber.
3. The temperature of the residence chamber is approximately 1450F.

EPA Response

According to §60.50c, the affected facility to which 40 CFR part 60 subpart Ec applies is each individual hospital/medical/infectious waste incinerator (HMIWI) constructed, in relevant part, after December 1, 2008. HMIWI is defined at §60.51c as "any device that combusts any amount of hospital waste and/or medical/infectious waste." eCycling provides that the CoronaLux system will be used to destroy hospital, medical and infectious waste and will be constructed after December 1, 2008.

There is an exemption at §60.50c(f) for "any pyrolysis unit" where the term "pyrolysis" is defined at §60.51c as the "endothermic gasification of hospital waste and/or medical/infectious waste using external energy."[5]

We do not believe that the exemption for "any pyrolysis unit" is applicable to the CoronaLux system. In past communications with EPA (see July 21, 2015, email from Fortunato Villamagna (Paragon Waste Solutions, LLC) to Marcia Mia (EPA)), the process in the primary chamber of

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[4] See "Using Non-Thermal Plasma to Control Air Pollutants" EPA-456/R-05-001; February 2005

[5] EPA discussed pyrolysis in the June 20, 1996 re-proposal for HMIWI (see 61 FR 31736) and concurrently developed a draft regulation for pyrolysis units (see Legacy Air Docket A-91-61, Item IV-B-56). In the September 15, 1997 final rule (see 62 FR 48348) EPA deferred on developing standards for pyrolysis units and determined that the HMIWI standards were not appropriate for pyrolysis units. Subsequently, the exemption and definition of "pyrolysis unit" was promulgated at §§60.50c(f) and 60.51c, respectively.

the CoronaLux system has been described by you as a "pyrolysis" process, however, additional information that we obtained from you indicate that the three chambers (primary, low energy plasma and residence) operate as a system and therefore we should evaluate them as a system. This is because the gas stream generated in one unit is immediately and continuously routed to the next unit and the operation of the prior unit is integral to the operation of the subsequent unit. Emissions are not emitted to the atmosphere until the gases have passed through all three chambers. Some of the units, according to your explanations, are endothermic (e.g., the primary chamber) while some are exothermic (e.g., the low energy plasma chamber and residence chamber). Therefore, because the CoronoLux system is not "endothermic" throughout the system, we do not believe that the CoronaLux system meets the exemption for "any pyrolysis unit" as "pyrolysis" is defined in the HMIWI standards. However, this alone does not mean that the system is therefore subject to the HMIWI standards.

In the February 27, 1995 proposed rule[6], we describe a typical HMIWI design system:

> In each of the design systems, sequential combustion operations typically are carried out in two separate chambers: primary and secondary. In the primary chamber, the waste is loaded and ignited, the volatile organic components driven off, and the nonvolatile materials combusted to ash. The volatile organic components released from the primary chamber are combusted in the secondary chamber. (See 60 FR 10670).

We promulgated the definition of the two chambers as follows:

> *Primary Chamber* means the chamber in an HMIWI that receives waste material, in which the waste is ignited, and from which ash is removed.

And

> *Secondary chamber* means a component of the HMIWI that receives combustion gases from the primary chamber and in which the combustion process is completed.
> See §60.51c Definitions.

As provided in your description, the CoronaLux primary chamber volatilizes any intermediate char, oils, or related products to produce a gas that contains hydrocarbons, oil droplets (aerosol), some carbon particulate, carbon monoxide, and other trace components in an endothermic system using low levels of oxygen and no direct contact with a flame. Your description of the CoronaLux primary chamber also provides that the design will prohibit the ignition of the waste by the flame by the metal shield installation which will completely cover the flame and that the temperature profile of the CoronaLux primary chamber will preclude auto-ignition of the waste.

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[6] The 1995 proposal was largely changed by the 1996 re-proposal. However, neither the definitions of "primary" and "secondary" chamber, nor the basic description of the HMIW incinerator as consisting of a "primary" and "secondary" chamber were altered by the re-proposal. In fact, the 1996 re-proposal discussed the use of the "primary" chamber as a method of determining the size of the HMIWI.

However, in an email of September 9, 2015, you provided temperature plots of a similar unit[7] (See Figure 1) and described those plots as follows:

> …the temperature profile shows a 6 minute purge cycle, followed by the burners turning on in the main chamber. The inflection in the graph is a clear indication of the change. During the first iteration the burners are on for about two minutes, and then turned off – note the slope change in the line. The burners come on once more during the second iteration, run for less than a minute until the slope changes again, and then (in this case) were off for the rest of the run. They would have turned back on if the temperature had dropped to the low temperature set point on the PLC, but this did not happen.
>
> The air valves started to close slightly before the burners came on. The waste begins to off-gas at the 500F mark, and based on the additive (slope 2 is > slope 1) inflection in the line should be off-gassing sustainably by 700F. At that point the burner and air (burner) is off.

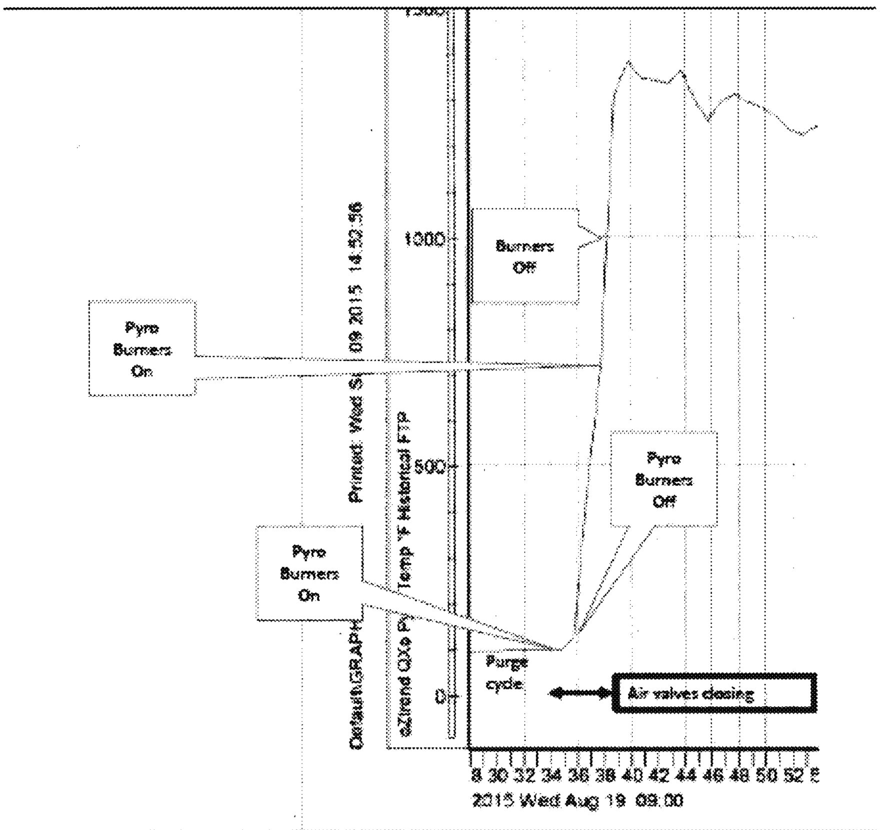

Figure 1

[7] EPA understands that a plot specific to the eCycling unit has not been generated as the unit is not operational. According to your email "[eCycling] will need to work out the specifics for e-Cycling, but the pattern will be approximately correct."

We believe that it is evidenced by the temperature profile that beginning at the "34" mark and within the next approximately six minutes (to about the "40" mark) the process is combustion, as the temperature rises even with the burners off. We also believe that combustion is contributing to some extent to the ability of the 1000 ft3 refractory lined chamber materials to go from 100° F to 1500 °F within 8 min and hold the heat at 1200° F for 2 hours. Finally, from the description you provide of the primary chamber (see Item 3 and 5 from the "Primary Chamber" fact pattern), you describe "ignition temperature of the waste". This conforms to the definition of the "primary chamber" as in the HMIWI rule:

> Primary Chamber means the chamber in an HMIWI that receives waste material, in which the waste is ignited, and from which ash is removed. (See §60.51c)

The gas from the CoronoLux primary chamber is routed to the low energy plasma chamber where the gases are exposed to a low energy electron gun. The low energy electron gun creates an electron cascade at the end of the tube and releases these electrons into the chamber. You state that the electron gun is not a high temperature source and is characterized by a low thermal load, with very high kinetic energy. The high kinetic energy of the electrons cause the electrons to collide with molecules in the chamber, and in turn ionize those molecules, creating free radicals. The ionized molecules of free radicals formed subsequently react with the hydrocarbon stream to accelerate the free radical oxidation process that naturally takes place with hydrocarbons. This stream is subsequently routed to the residence chamber where the oxidation process is completed.

Since we have determined that the CoronaLux primary chamber is a "primary chamber" as that term is defined at §60.51c, we next evaluate the low energy plasma chamber and the residence chamber as "secondary chambers" under the same section. Both chambers meet the definition of "a component of the HMIWI that receives combustion gases from the primary chamber" (since we determined that the primary chamber is conducting combustion during at least part of the process) and "in which the combustion process is completed" (because the low energy plasma chamber and residence chamber complete the process which is initiated in the primary chamber).

Therefore, we believe that the CoronaLux system is subject to 40 CFR part 60 subpart Ec.

This determination is based on the fact pattern that was mutually agreed upon between eCycling and US EPA. Should any of the fact pattern change, then a new applicability determination may need to be made. This determination was coordinated with the Office of Air Quality Planning and Standards, the Office of General Counsel and EPA Region IV. If you have any questions, please contact my staff, Marcia Mia, at (202)564-7042.

Sincerely,

Edward J. Messina

Edward J. Messina, Director
Monitoring, Assistance and Media Programs Division

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